



prostate cancer

Prostate cancer is a common disease that affects men, usually in middle age or later. In this disorder, certain cells in the prostate become abnormal and multiply without control or order to form a tumor. The prostate is a gland that surrounds the male urethra and helps produce semen, the fluid that carries sperm.

Early prostate cancer usually does not cause pain, and most affected men exhibit no noticeable symptoms. Men are often diagnosed as the result of health screenings, such as a blood test for a substance called prostate specific antigen (PSA) or a medical procedure called a digital rectal exam. As the tumor grows larger, signs and symptoms can include difficulty starting or stopping the flow of urine, a feeling of not being able to empty the bladder completely, blood in the urine or semen, or pain with ejaculation. However, these changes can also occur with many other genitourinary conditions. Having one or more of these symptoms does not necessarily mean that a man has prostate cancer.

The severity and outcome of prostate cancer varies widely. Early-stage prostate cancer can usually be treated successfully, and some older men have prostate tumors that grow so slowly that they may never cause health problems during their lifetime, even without treatment. In other men, however, the cancer is much more aggressive; in these cases, prostate cancer can be life-threatening.

Some cancerous tumors can invade surrounding tissue and spread to other parts of the body. Tumors that begin at one site and then spread to other areas of the body are called metastatic cancers. The signs and symptoms of metastatic cancer depend on where the disease has spread. If prostate cancer spreads, cancerous cells most often appear in the lymph nodes, bones, lungs, liver, or brain. Bone metastases of prostate cancer most often cause pain in the lower back, pelvis, or hips.

A small percentage of all prostate cancers cluster in families. These hereditary cancers are associated with inherited gene mutations. Hereditary prostate cancers tend to develop earlier in life than non-inherited (sporadic) cases.

Frequency

About 1 in 7 men will be diagnosed with prostate cancer at some time during their life. In addition, studies indicate that many older men have undiagnosed prostate cancer that is non-aggressive and unlikely to cause symptoms or affect their lifespan. While most men who are diagnosed with prostate cancer do not die from it, this common cancer is still the second leading cause of cancer death among men in the United States.

More than 60 percent of prostate cancers are diagnosed after age 65, and the disorder is rare before age 40. In the United States, African Americans have a higher risk of developing prostate cancer than do men of other ethnic backgrounds, and they also have a higher risk of dying from the disease.

Genetic Changes

Cancers occur when genetic mutations build up in critical genes, specifically those that control cell growth and division or the repair of damaged DNA. These changes allow cells to grow and divide uncontrollably to form a tumor. In most cases of prostate cancer, these genetic changes are acquired during a man's lifetime and are present only in certain cells in the prostate. These changes, which are called somatic mutations, are not inherited. Somatic mutations in many different genes have been found in prostate cancer cells. Less commonly, genetic changes present in essentially all of the body's cells increase the risk of developing prostate cancer. These genetic changes, which are classified as germline mutations, are usually inherited from a parent. In people with germline mutations, changes in other genes, together with environmental and lifestyle factors, also influence whether a person will develop prostate cancer.

Inherited mutations in particular genes, such as *BRCA1*, *BRCA2*, and *HOXB13*, account for some cases of hereditary prostate cancer. Men with mutations in these genes have a high risk of developing prostate cancer and, in some cases, other cancers during their lifetimes. In addition, men with *BRCA2* or *HOXB13* gene mutations may have a higher risk of developing life-threatening forms of prostate cancer.

The proteins produced from the *BRCA1* and *BRCA2* genes are involved in fixing damaged DNA, which helps to maintain the stability of a cell's genetic information. For this reason, the *BRCA1* and *BRCA2* proteins are considered to be tumor suppressors, which means that they help keep cells from growing and dividing too fast or in an uncontrolled way. Mutations in these genes impair the cell's ability to fix damaged DNA, allowing potentially damaging mutations to persist. As these defects accumulate, they can trigger cells to grow and divide uncontrollably and form a tumor.

The *HOXB13* gene provides instructions for producing a protein that attaches (binds) to specific regions of DNA and regulates the activity of other genes. On the basis of this role, the protein produced from the *HOXB13* gene is called a transcription factor. Like *BRCA1* and *BRCA2*, the *HOXB13* protein is thought to act as a tumor suppressor. *HOXB13* gene mutations may result in impairment of the protein's tumor suppressor function, resulting in the uncontrolled cell growth and division that can lead to prostate cancer.

Inherited variations in dozens of other genes have been studied as possible risk factors for prostate cancer. Some of these genes provide instructions for making proteins that interact with the proteins produced from the *BRCA1*, *BRCA2*, or *HOXB13* genes. Others act as tumor suppressors through different pathways. Changes in these genes probably make only a small contribution to overall prostate cancer risk. However,

researchers suspect that the combined influence of variations in many of these genes may significantly impact a person's risk of developing this form of cancer.

In many families, the genetic changes associated with hereditary prostate cancer are unknown. Identifying additional genetic risk factors for prostate cancer is an active area of medical research.

In addition to genetic changes, researchers have identified many personal and environmental factors that may contribute to a person's risk of developing prostate cancer. These factors include a high-fat diet that includes an excess of meat and dairy and not enough vegetables, a largely inactive (sedentary) lifestyle, obesity, excessive alcohol use, or exposure to certain toxic chemicals. A history of prostate cancer in closely related family members is also an important risk factor, particularly if the cancer occurred at an early age.

Inheritance Pattern

Many cases of prostate cancer are not related to inherited gene changes. These cancers are associated with somatic mutations that occur only in certain cells in the prostate.

When prostate cancer is related to inherited gene changes, the way that cancer risk is inherited depends on the gene involved. For example, mutations in the *BRCA1*, *BRCA2*, and *HOXB13* genes are inherited in an autosomal dominant pattern, which means one copy of the altered gene in each cell is sufficient to increase a person's chance of developing cancer. In other cases, the inheritance of prostate cancer risk is unclear. It is important to note that people inherit an increased risk of cancer, not the disease itself. Not all people who inherit mutations in these genes will develop cancer.

Other Names for This Condition

- cancer of the prostate
- malignant neoplasm of the prostate
- prostate carcinoma
- prostate neoplasm
- prostatic cancer
- prostatic carcinoma
- prostatic neoplasm

Diagnosis & Management

Genetic Testing

- Genetic Testing Registry: Familial prostate cancer
<https://www.ncbi.nlm.nih.gov/gtr/conditions/CN036094/>
- Genetic Testing Registry: Prostate cancer aggressiveness quantitative trait locus on chromosome 19
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1843533/>
- Genetic Testing Registry: Prostate cancer, hereditary, 1
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C2931456/>
- Genetic Testing Registry: Prostate cancer, hereditary, 2
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C3539120/>
- Genetic Testing Registry: Prostate cancer, hereditary, 3
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1837595/>
- Genetic Testing Registry: Prostate cancer, hereditary, 4
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1837593/>
- Genetic Testing Registry: Prostate cancer, hereditary, 5
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1836436/>
- Genetic Testing Registry: Prostate cancer, hereditary, 6
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1836005/>
- Genetic Testing Registry: Prostate cancer, hereditary, 7
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1853195/>
- Genetic Testing Registry: Prostate cancer, hereditary, 8
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1864472/>
- Genetic Testing Registry: Prostate cancer, hereditary, 9
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1970250/>
- Genetic Testing Registry: Prostate cancer, hereditary, 10
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1970192/>
- Genetic Testing Registry: Prostate cancer, hereditary, 11
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C2677773/>
- Genetic Testing Registry: Prostate cancer, hereditary, 12
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C2678479/>
- Genetic Testing Registry: Prostate cancer, hereditary, 13
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C2677821/>
- Genetic Testing Registry: Prostate cancer, hereditary, 14
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C2677772/>

- Genetic Testing Registry: Prostate cancer, hereditary, 15
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C2677771/>
- Genetic Testing Registry: Prostate cancer, hereditary, X-linked 1
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1846279/>
- Genetic Testing Registry: Prostate cancer, hereditary, X-linked 2
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C2678047/>
- Genetic Testing Registry: Prostate cancer/brain cancer susceptibility
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C1863600/>

Other Diagnosis and Management Resources

- American College of Radiology: Prostate Cancer Radiation Treatment
https://www.radiologyinfo.org/en/info.cfm?pg=pros_cancer
- MedlinePlus Encyclopedia: Prostate Brachytherapy
<https://medlineplus.gov/ency/article/007385.htm>
- MedlinePlus Encyclopedia: Prostate Cancer Staging
<https://medlineplus.gov/ency/patientinstructions/000397.htm>
- MedlinePlus Encyclopedia: Prostate Cancer Treatment
<https://medlineplus.gov/ency/patientinstructions/000403.htm>
- MedlinePlus Encyclopedia: Prostate-Specific Antigen (PSA) Blood Test
<https://medlineplus.gov/ency/article/003346.htm>
- MedlinePlus Encyclopedia: Radical Prostatectomy
<https://medlineplus.gov/ency/article/007300.htm>
- MedlinePlus Health Topic: Prostate Cancer Screening
<https://medlineplus.gov/prostatecancerscreening.html>
- National Cancer Institute: Prostate-Specific Antigen (PSA) Test
<https://www.cancer.gov/types/prostate/psa-fact-sheet>
- U.S. Preventive Services Task Force
<https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/prostate-cancer-screening>

General Information from MedlinePlus

- Diagnostic Tests
<https://medlineplus.gov/diagnostictests.html>
- Drug Therapy
<https://medlineplus.gov/drugtherapy.html>
- Genetic Counseling
<https://medlineplus.gov/geneticcounseling.html>

- Palliative Care
<https://medlineplus.gov/palliativecare.html>
- Surgery and Rehabilitation
<https://medlineplus.gov/surgeryandrehabilitation.html>

Additional Information & Resources

MedlinePlus

- Encyclopedia: Prostate Brachytherapy
<https://medlineplus.gov/ency/article/007385.htm>
- Encyclopedia: Prostate Cancer
<https://medlineplus.gov/ency/article/000380.htm>
- Encyclopedia: Prostate Cancer Staging
<https://medlineplus.gov/ency/patientinstructions/000397.htm>
- Encyclopedia: Prostate Cancer Treatment
<https://medlineplus.gov/ency/patientinstructions/000403.htm>
- Encyclopedia: Prostate-Specific Antigen (PSA) Blood Test
<https://medlineplus.gov/ency/article/003346.htm>
- Encyclopedia: Radical Prostatectomy
<https://medlineplus.gov/ency/article/007300.htm>
- Health Topic: Prostate Cancer
<https://medlineplus.gov/prostatecancer.html>
- Health Topic: Prostate Cancer Screening
<https://medlineplus.gov/prostatecancerscreening.html>

Genetic and Rare Diseases Information Center

- Familial prostate cancer
<https://rarediseases.info.nih.gov/diseases/4520/familial-prostate-cancer>

Additional NIH Resources

- National Cancer Institute: General Information About Prostate Cancer
<https://www.cancer.gov/types/prostate/patient/prostate-treatment-pdq>
- National Cancer Institute: Prostate-Specific Antigen (PSA) Test
<https://www.cancer.gov/types/prostate/psa-fact-sheet>
- National Human Genome Research Institute: Learning About Prostate Cancer
<https://www.genome.gov/10003559/learning-about-prostate-cancer/>

- National Institute on Aging: Prostate Problems
<https://www.nia.nih.gov/health/publication/prostate-problems>
- NIH SeniorHealth: Prostate Cancer
<https://nihseniorhealth.gov/prostatecancer/prostatecancerdefined/01.html>

Educational Resources

- Agency for Healthcare Research and Quality: Localized Prostate Cancer
<http://www.effectivehealthcare.ahrq.gov/ehc/decisionaids/prostate-cancer/>
- Centers for Disease Control and Prevention
<https://www.cdc.gov/cancer/prostate/>
- Disease InfoSearch: Prostate cancer
<http://www.diseaseinfosearch.org/Prostate+cancer/9175>
- Disease InfoSearch: Prostate cancer-brain cancer susceptibility
<http://www.diseaseinfosearch.org/Prostate+cancer-brain+cancer+susceptibility/9179>
- Disease InfoSearch: Prostate cancer, hereditary, 1
<http://www.diseaseinfosearch.org/Prostate+cancer%2C+hereditary%2C+1/9176>
- Disease InfoSearch: Prostate cancer, hereditary, 12
<http://www.diseaseinfosearch.org/Prostate+cancer%2C+hereditary%2C+12/9177>
- Disease InfoSearch: Prostate cancer, hereditary, 13
<http://www.diseaseinfosearch.org/Prostate+cancer%2C+hereditary%2C+13/9178>
- MalaCards: prostate cancer
http://www.malacards.org/card/prostate_cancer
- Orphanet: Familial prostate cancer
http://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=1331

Patient Support and Advocacy Resources

- American Cancer Society
<https://www.cancer.org/cancer/prostate-cancer.html>
- CancerCare
http://www.cancercare.org/diagnosis/prostate_cancer
- National Coalition for Cancer Survivorship
<http://www.canceradvocacy.org/>
- Prostate Cancer Foundation
<https://www.pcf.org/>

ClinicalTrials.gov

- ClinicalTrials.gov
<https://clinicaltrials.gov/ct2/results?cond=%22prostate+cancer%22>

Scientific Articles on PubMed

- PubMed
<https://www.ncbi.nlm.nih.gov/pubmed?term=%28Prostatic+Neoplasms%5BMAJR%5D%29+AND+%28prostate+cancer%5BTI%5D%29+AND+genetics%5Bmh%5D+AND+review%5Bpt%5D+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+1800+days%22%5Bdp%5D>

OMIM

- PROSTATE CANCER
<http://omim.org/entry/176807>
- PROSTATE CANCER AGGRESSIVENESS QUANTITATIVE TRAIT LOCUS ON CHROMOSOME 19
<http://omim.org/entry/607592>
- PROSTATE CANCER ANTIGEN 3
<http://omim.org/entry/604845>
- PROSTATE CANCER-ASSOCIATED NONCODING RNA 1
<http://omim.org/entry/615452>
- PROSTATE CANCER-ASSOCIATED PROTEIN 2
<http://omim.org/entry/605095>
- PROSTATE CANCER-ASSOCIATED PROTEIN 8
<http://omim.org/entry/605099>
- PROSTATE CANCER-ASSOCIATED TRANSCRIPT 4
<http://omim.org/entry/609717>
- PROSTATE CANCER, HEREDITARY, 1
<http://omim.org/entry/601518>
- PROSTATE CANCER, HEREDITARY, 2
<http://omim.org/entry/614731>
- PROSTATE CANCER, HEREDITARY, 3
<http://omim.org/entry/608656>
- PROSTATE CANCER, HEREDITARY, 4
<http://omim.org/entry/608658>
- PROSTATE CANCER, HEREDITARY, 5
<http://omim.org/entry/609299>

- PROSTATE CANCER, HEREDITARY, 6
<http://omim.org/entry/609558>
- PROSTATE CANCER, HEREDITARY, 7
<http://omim.org/entry/610321>
- PROSTATE CANCER, HEREDITARY, 8
<http://omim.org/entry/602759>
- PROSTATE CANCER, HEREDITARY, 9
<http://omim.org/entry/610997>
- PROSTATE CANCER, HEREDITARY, 10
<http://omim.org/entry/611100>
- PROSTATE CANCER, HEREDITARY, 11
<http://omim.org/entry/611955>
- PROSTATE CANCER, HEREDITARY, 12
<http://omim.org/entry/611868>
- PROSTATE CANCER, HEREDITARY, 13
<http://omim.org/entry/611928>
- PROSTATE CANCER, HEREDITARY, 14
<http://omim.org/entry/611958>
- PROSTATE CANCER, HEREDITARY, 15
<http://omim.org/entry/611959>
- PROSTATE CANCER, HEREDITARY, X-LINKED 1
<http://omim.org/entry/300147>
- PROSTATE CANCER, HEREDITARY, X-LINKED 2
<http://omim.org/entry/300704>
- PROSTATE CANCER/BRAIN CANCER SUSCEPTIBILITY
<http://omim.org/entry/603688>

Sources for This Summary

- Bambury RM, Gallagher DJ. Prostate cancer: germline prediction for a commonly variable malignancy. *BJU Int.* 2012 Dec;110(11 Pt C):E809-18. doi: 10.1111/j.1464-410X.2012.11450.x. Epub 2012 Sep 14. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/22974436>
- Barbieri CE, Bangma CH, Bjartell A, Catto JW, Culig Z, Grönberg H, Luo J, Visakorpi T, Rubin MA. The mutational landscape of prostate cancer. *Eur Urol.* 2013 Oct;64(4):567-76. doi: 10.1016/j.eururo.2013.05.029. Epub 2013 May 18. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/23759327>
Free article on PubMed Central: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4342117/>

- Barbieri CE, Tomlins SA. The prostate cancer genome: perspectives and potential. *Urol Oncol*. 2014 Jan;32(1):53.e15-22. doi: 10.1016/j.urolonc.2013.08.025. Epub 2013 Nov 13. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/24239470>
- Beltran H, Rubin MA. New strategies in prostate cancer: translating genomics into the clinic. *Clin Cancer Res*. 2013 Feb 1;19(3):517-23. doi: 10.1158/1078-0432.CCR-12-1452. Epub 2012 Dec 17. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/23248095>
Free article on PubMed Central: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4123124/>
- Castro E, Eeles R. The role of BRCA1 and BRCA2 in prostate cancer. *Asian J Androl*. 2012 May; 14(3):409-14. doi: 10.1038/aja.2011.150. Epub 2012 Apr 23. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/22522501>
Free article on PubMed Central: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3720154/>
- Eeles R, Goh C, Castro E, Bancroft E, Guy M, Al Olama AA, Easton D, Kote-Jarai Z. The genetic epidemiology of prostate cancer and its clinical implications. *Nat Rev Urol*. 2014 Jan;11(1):18-31. doi: 10.1038/nrurol.2013.266. Epub 2013 Dec 3. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/24296704>
- Helfand BT, Catalona WJ. The epidemiology and clinical implications of genetic variation in prostate cancer. *Urol Clin North Am*. 2014 May;41(2):277-97. doi: 10.1016/j.ucl.2014.01.001. Epub 2014 Feb 28. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/24725490>
- Hoffmann TJ, Sakoda LC, Shen L, Jorgenson E, Habel LA, Liu J, Kvale MN, Asgari MM, Banda Y, Corley D, Kushi LH, Quesenberry CP Jr, Schaefer C, Van Den Eeden SK, Risch N, Witte JS. Imputation of the rare HOXB13 G84E mutation and cancer risk in a large population-based cohort. *PLoS Genet*. 2015 Jan 28;11(1):e1004930. doi: 10.1371/journal.pgen.1004930. eCollection 2015 Jan. Erratum in: *PLoS Genet*. 2015 Jun;11(6):e1005362. *PLoS Genet*. 2015 Apr;11(4):e1005114.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/25629170>
Free article on PubMed Central: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4309593/>
- Huang J, Wang JK, Sun Y. Molecular pathology of prostate cancer revealed by next-generation sequencing: opportunities for genome-based personalized therapy. *Curr Opin Urol*. 2013 May;23(3): 189-93. doi: 10.1097/MOU.0b013e32835e9ef4. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/23385974>
Free article on PubMed Central: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4086526/>
- Lin X, Qu L, Chen Z, Xu C, Ye D, Shao Q, Wang X, Qi J, Chen Z, Zhou F, Wang M, Wang Z, He D, Wu D, Gao X, Yuan J, Wang G, Xu Y, Wang G, Dong P, Jiao Y, Yang J, Ou-Yang J, Jiang H, Zhu Y, Ren S, Zhang Z, Yin C, Wu Q, Zheng Y, Turner AR, Tao S, Na R, Ding Q, Lu D, Shi R, Sun J, Liu F, Zheng SL, Mo Z, Sun Y, Xu J. A novel germline mutation in HOXB13 is associated with prostate cancer risk in Chinese men. *Prostate*. 2013 Jan;73(2):169-75. doi: 10.1002/pros.22552. Epub 2012 Jun 21.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/22718278>
Free article on PubMed Central: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3755486/>
- Nakagawa H. Prostate cancer genomics by high-throughput technologies: genome-wide association study and sequencing analysis. *Endocr Relat Cancer*. 2013 Jun 24;20(4):R171-81. doi: 10.1530/ERC-13-0113. Print 2013 Aug. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/23625613>

- Roychowdhury S, Chinnaiyan AM. Advancing precision medicine for prostate cancer through genomics. J Clin Oncol. 2013 May 20;31(15):1866-73. doi: 10.1200/JCO.2012.45.3662. Epub 2013 Apr 15. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/23589550>
Free article on PubMed Central: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3808235/>
 - Sissung TM, Price DK, Del Re M, Ley AM, Giovannetti E, Figg WD, Danesi R. Genetic variation: effect on prostate cancer. Biochim Biophys Acta. 2014 Dec;1846(2):446-56. doi: 10.1016/j.bbcan.2014.08.007. Epub 2014 Sep 6. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/25199985>
Free article on PubMed Central: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4260983/>
-

Reprinted from Genetics Home Reference:
<https://ghr.nlm.nih.gov/condition/prostate-cancer>

Reviewed: April 2015

Published: March 21, 2017

Lister Hill National Center for Biomedical Communications
U.S. National Library of Medicine
National Institutes of Health
Department of Health & Human Services